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JC14 Rec'd PCT/PTO 04 MAY 2005A CAR PARK

## FIELD OF THE INVENTION

The present invention relates to a car park or parking  
5 garage, and to a storage facility.

## BACKGROUND OF THE INVENTION

Existing multilevel car parks provide multiple parking compartments or platforms, each generally accessible by  
10 means of a sequence of ramps joining each level. The ramps may be essentially straight or, in some existing car parks, spiral. The ramps, however, consume a substantial amount of space that ideally would be devoted to parking compartments.

15 This problem has been addressed in some existing car parks by providing a multilevel car park with one or more hoists, for transporting the cars to the parking compartments. This reduces or eliminates the need for  
20 ramps. For example, CH 686,896 discloses a car park comprising a silo with radiating parking compartments at each level. The parking compartments at any particular level form an annulus. In the centre of the silo - within the annuluses - is a central shaft with a hoist for  
25 raising and lowering cars between the different levels, including ground level. Each car is either driven from the hoist into a vacant parking compartment or drawn from the hoist by mechanical means into the parking compartment.

30 Another existing system, the Trevipark (TM) parking system, comprises a multi-level automated car park that stores cars with the aid of a stacking system and usually underground. A typical Trevipark (TM) parking system  
35 stores up to 108 cars, with 12 parking spaces per level on each of 9 levels. Its structure is circular, and incorporates a central rotating lift mechanism for the

placement and retrieval of vehicles.

Another existing system, the Robotic Parking (TM) parking system, comprises a generally rectangular construction.

5      Unlike the Trevipark (TM) system, it does not have any revolving elements. Rather, the Robotic Parking (TM) parking system uses vertical lifts and lateral conveyor transportation to place and retrieve vehicles, in order to minimise the area required by access aisles. This system

10     thus resembles in many respects older, conventional parking structures.

#### SUMMARY OF THE INVENTION

It is an object of the present invention to provide a car park in which a higher parking density can be achieved in an alternative to existing approaches.

The present invention provides a car park comprising:

20        a plurality of annular parking levels;

              an outer structure and a central core for supporting said parking levels; and

              a hoisting mechanism;

              wherein each of said plurality of parking levels comprises a plurality of parking compartments located between said outer structure and said inner core, each of said levels is rotatable to bring a respective compartment into alignment with said hoisting mechanism so that said respective compartment can be detached from said respective level and raised or lowered by said hoisting mechanism.

It will be understood that the car park of the invention can be used to park vehicles other than cars, and that the term "car park" is regarded throughout as synonymous with "parking garage."

Thus, it is not necessary to provide separate hoist

platforms and parking compartments, as each parking compartment acts as necessary as a hoist platform.

In one embodiment the hoisting mechanism is arranged to 5 raise or lower said compartments vertically. In another embodiment the hoisting mechanism is arranged to raise or lower the parking compartments in a spiral shaped lift well.

10 Thus, in the former of these embodiments each parking compartment is moved through the shortest distance between levels, but in the latter embodiment a reduced lifting force can be used by taking advantage of the mechanical advantage provided by employing a spiral motion.

15 The car park includes at least one entrance level at which cars may enter said car park and park on an available one of said parking compartments, whereby said available parking compartment (now occupied) is movable to a parking 20 location. This movement optionally includes either or both: rotation to engage said hoisting mechanism and upward or downward movement by means of said hoisting mechanism. This movement generally always includes rotation at a final parking level out of engagement with 25 said hoisting mechanism to a final parking location.

The entry level can be at ground level at the bottom of an above ground car park, at ground level at the top of a substantially underground car park, or at an intermediate 30 level of a car park (whether the car park is below ground, above ground or partially above and below ground). In addition, the car park need not be a free-standing structure. While it can be free-standing, an alternative embodiment has the car park incorporated into another 35 structure (such as an office building). In this latter case, the outer structure of the car park may be or include portions of that other structure.

In one embodiment, the car park has multiple entrance levels so that cars may enter said car park more quickly. Preferably the car park exit corresponds with the car park entrance, but this need not be the case; for example, the car park exit could be located in a different level from the car park entrance so that a car can be moved through the exit for exiting while another car enters the entrance in anticipation of being moved to a suitable parking location.

In one embodiment, the car park includes a plurality of hoisting mechanisms.

Thus, for example, separate hoisting mechanisms could be located 180° apart; although this would generally reduce the number of parking compartments, it might be desirable where speed of vehicle entrance and exit is particularly important.

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In another embodiment, at least some of the parking compartments are adapted to receive more than one vehicle.

Thus, especially where vehicles are parked with high frequency, more than one could be accommodated in or on a single parking compartment. This would allow, for example, two vehicles to park and be stored at the same time. In this embodiment, when one of such vehicles is desired, the other would also be moved to the exit level but simply returned with a new second vehicle (if there remains a high demand for parking), or returned to a parking location alone.

Preferably at least one drive segment is provided at each level for rotating said plurality of parking compartments.

Generally the drive segment (or drive platform) does not

comprise a parking platform, and is therefore not - in use - removed from its respective level.

In one embodiment, said plurality of annular parking  
5 levels constitutes a first parking circuit and said car park includes at least one additional parking circuit comprising a further plurality of annular parking levels, wherein said first parking circuit and said additional parking circuit are coaxial.

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The levels of the further (or outer) circuit may or may not be aligned vertically with those of the inner (or first) circuit.

15 The present invention also provides a storage facility, comprising:

a plurality of annular storage levels;  
an outer structure and a central core for supporting said storage levels; and  
20 a hoisting mechanism;  
wherein each of said plurality of storage levels comprises a plurality of storage compartments located between said outer structure and said inner core, each of said levels is rotatable to bring a respective compartment into alignment with said hoisting mechanism so that said respective compartment can be detached from said respective level and raised or lowered by said hoisting mechanism.

25 Thus, the invention provides a storage facility for essentially any object, in which case cars may be regarded as simply one example of such storable objects. As will be appreciated, the size and mechanical demands of the facility will depend on the nature of the object or  
30 objects to be stored.

35 Preferably each compartment includes or comprises a

container adapted for the intended stored type of article or articles.

Thus, more than one type of article could be stored, and  
5 one or more types of container of suitable design for the intended articles.

Preferably at least one drive segment is provided at each level for rotating said plurality of storage compartments.

10 Generally the drive segment does not comprise a storage compartment, and is therefore not - in use - removed from its respective level.

15 In one embodiment, said plurality of annular storage levels constitutes a first storage circuit and said storage facility includes at least one additional storage circuit comprising a further plurality of annular storage levels, wherein said first storage circuit and said  
20 additional storage circuit are coaxial.

The levels of the further (or outer) circuit may or may not be aligned vertically with those of the inner (or first) circuit.

25 **BRIEF DESCRIPTION OF THE DRAWING**  
In order that the present invention may be more clearly ascertained, preferred embodiments will now be described, by way of example, with reference to the accompanying  
30 drawings, in which:

Figure 1 is a schematic view of a car park according to a first preferred embodiment of the present invention;

35 Figure 2 is a cross-sectional view of the car park of figure 1 in use;

Figure 3A is a cross-sectional view of a parking platform of the car park of figure 1;

Figure 3B is a cross-sectional view of a parking platform engaged with the hoisting mechanism of the car park of figure 1;

5 Figure 3C is a schematic view of a parking platform engaged with the hoisting mechanism, comparable to figure 3B;

Figure 3D is a cross-sectional view comparable to figure 3B of a parking platform engaged with an alternative hoisting mechanism of the present invention;

10 Figure 4 is a schematic view of the hoisting and rotating mechanism of the car park of figure 1;

Figure 5 is a plan view of a filled level of the car park of figure 1;

15 Figure 6 is a plan view comparable to figure 5, illustrating the rotation of the levels shown in figure 5;

Figure 7 is a schematic view of the level of figure 6 illustrating the exiting of a car from that level;

20 Figures 8A to 8D are more detailed view of a single parking platform of the car park of figure 1;

Figure 9 is a schematic view of a level of a car park according to a second preferred embodiment of the present invention;

25 Figure 10 is a schematic view of the drive platform of the level of figure 9;

Figure 11 is a schematic view of a level of a car park according to a third preferred embodiment of the present invention;

30 Figure 12 is a perspective view of a car park according to a fourth further preferred embodiment of the present invention *in situ*;

Figures 13A to 13F are a sequence of views of the car park of figure 12 at sequential phases of its use, in which figures 13A to 13C, 13E and 13F are plan views and 35 figure 13D is a partial cross sectional elevation;

Figure 14 is a plan view of a variation of the embodiment of figures 12 to 13F, comparable to that of

figure 13E;

Figure 15 is a plan view of a further variation of the embodiment of figures 12 to 13F, also comparable to that of figure 13E;

5 Figures 16A to 16F are a sequence of views of a double ring car park according to a fifth preferred embodiment of the present invention, comparable to the views of figures 13A to 13F respectively;

10 Figure 17 is a plan view of a variation of the embodiment of figures 16A to 16F, comparable to that of figure 16E; and

15 Figure 18 is a plan view of a further variation of the embodiment of figures 16A to 16F, also comparable to that of figure 16E.

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#### DETAILED DESCRIPTION

A car park according to a first preferred embodiment of the present invention is shown generally at 10 in figure 1. In this embodiment, the car park 10 is an above-ground car park, though it will be appreciated that it could in some embodiments be partially or wholly below ground.

25 Car park 10 includes an inner core 12 and an outer supporting structure 14, and comprises a plurality of annular parking levels 16a, 16b, 16c, etc. Each level comprises a plurality of parking compartments in the form of parking platforms, each of which comprises a sector of a respective annular parking level and extending between inner core 12 and outer structure 14.

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Car park 10 includes a vertical lift shaft 20, generally comprising vertically aligned gaps, one parking platform in width, in each of the parking levels 16a, 16b, etc.

35 In one alternative embodiment, the lift shaft has a spiral configuration in which the gaps are progressively offset around the vertical axis of the car park. This

configuration has the advantage of reducing the lifting force required to raise vehicles.

In another alternative embodiment, each level is offset 5 relative to its adjacent levels, so that the inner core is not vertical. The lift well in this embodiment is straight but slanted.

The overall dimensions of the car park can be chosen to 10 suit the application (including expected vehicle size, etc), but in this embodiment the car park 10 has 21 parking levels, each with 17 parking platforms. The outer circumference of each level is approximately 69.2 m. The height of the car park 10 is approximately 48 m.

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The vertical separation 26 of the parking levels, when used for parking passenger vehicles, is approximately 2.2 m.

20 Figure 2 is an essentially cross-sectional schematic view of the car park 10, occupied by a number of cars 32. In use, each car is raised in lift shaft 20 on a parking platform 24 to the desired level, as will be described in greater detail below. Each of the parking platforms 18, 25 24 (of steel or reinforced concrete) has a thickness of approximately 0.2 m.

Each parking level 16a, 16b, etc. is rotatable, so that 30 when parking platform 24 reaches the desired level, the level (including the parking platforms constituting that level and the just raised parking platform 24) is rotated so that the car being parked is moved out of the lift-well 20; an unoccupied parking platform is instead located in the lift-well 20. That unoccupied platform is then 35 lowered to the entrance level ready to receive the next car. Alternatively, if a driver wishes to retrieve his or her car at the same time as another car is being parked,

the car being parked can be raised to the same level as the desired car, after which that level can be rotated to bring the desired car into alignment with the lift-well so that the desired car can be lowered on its parking platform to the entrance/exit level (in this embodiment, ground level).

Detailed views of an individual parking platform are shown in figures 3A, 3B, 3C and 3D. Referring to figure 3A, each parking platform 30 is located between outer wall 14 and inner core 12. Each platform 30 and the other platforms at the same level are supported at their inner end by a principal inner bracket 32, which is itself supported by inner core 12 and is continuous apart from a gap coinciding with lift-well 20. This gap allows the lifting mechanism to raise or lower parking platforms within the lift-well 20. Principal inner bracket 32 includes a horizontal slot 34 for accommodating the parking platforms 30. The outer end of each parking platform 30 is supported by a principal outer bracket 36 supported by outer wall 14 and including a slot 38 for receiving each parking platform 30. As with inner bracket 32, principal outer bracket 36 circles the entire car park 10, apart from a gap coinciding with lift-well 20.

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Referring to figure 3B, the lift-well 20 (shown essentially in cross-section) can accommodate a single parking platform 40, raised or lowered by means of a hoisting or lifting mechanism. This mechanism includes inner lift bracket 42 and outer lift bracket 44 that are essentially identical in cross-section with principal inner bracket 32 and principal outer bracket 36 of each level. Brackets 42 and 44, however, have widths corresponding to the width of lift-well 20 at their respective locations. Lift brackets 42 and 44 retained and move in guides (not shown) in inner and outer walls 12, 14 and are raised or lowered by inner cables 46 and

outer cables 48. The necessary lift can be provided by any suitable hoist located above the upper most level of car park 10.

- 5 This arrangement is shown more clearly, schematically, in figure 3C in which it can be seen how inner lift bracket 42 and outer lift bracket 44 can be lifted to coincide with principal inner bracket 32 (principal inner bracket 44) so that parking platform 40 (being raised or lowered)  
10 10 can be brought into coincidence with other parking platforms already at that respective level.

An alternative configuration to that shown in figure 3B is shown in figure 3D. In this embodiment, the parking platform 40 and the bulk of the lifting mechanism is unchanged. However, the lifting mechanism is augmented by a rigid tie in the form of plate 45 joining inner lift bracket 42 and outer lift bracket 44. This plate 45 is located beneath the parking platform 40 and is of  
20 comparable width thereto, and serves to further fix inner lift bracket 42 and outer lift bracket 44 relative to each during raising and lowering of parking platform 40, particularly when carrying a vehicle. The plate 45 may also be provided with rollers or other comparable  
25 mechanisms to facilitate the sliding of each parking platform onto the lifting mechanism, particularly when loaded with a vehicle.

Optionally, the pairs of principal inner and outer brackets 32, 36 may also be provided with such a tie or ties, but as these brackets 32, 36 are not moved during the operation of the car park this is regarded as less important.

35 Figure 4 illustrates how the parking platforms at any single level are rotated so that a car that has been raised or lowered to that level can be moved out of the

lift-well and into a parking location or, alternatively, how a parked car can be brought to a lift-well so that it can be lowered to the ground and exit level. As explained above, the lifting mechanism includes inner lift bracket 5 42, the lower portion of which is shown in figure 4. When raised or lowered by the lifting mechanism, this bracket 42 coincides with the principal inner bracket 32.

In figure 4 is shown a representative parking platform 50, 10 whose inner end is exposed; in this figure the upper portion of inner bracket 32 is omitted for clarity (as is the upper portion of movable inner lift bracket 42).

Each parking level (such as the representative level shown 15 in figure 4) is provided with a drive for rotating parking platforms at that level. Although any suitable mechanism may be used to rotate the parking platforms that form a respective level, in this embodiment a continuous driven belt 52 is employed, located within principal inner bracket 32. A second, comparable belt (not shown) is also employed, located within principal outer bracket 36. Each of these belts has teeth corresponding to teeth along the inner periphery and outer periphery respectively of each parking platform 50. Each belt is driven by means of a 20 pair of drive wheels (for inner belt 52: drive wheels 54 and 56), provided in principal inner bracket 32 and principal outer bracket 36 respectively near the ends of the principal brackets adjacent the lift-well gap. Drive wheels 54 and 56 (and the corresponding drive wheels 25 driving the outer belt) are driven by means of a suitable electric motor. The drive belts are only operated when the lifting mechanism is positioned such that lift brackets 42 and 44 and a parking platform 40 are aligned 30 with that respective parking level.

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If a car is to be removed, the drive belts rotate the now complete circuit of parking platforms until the desired

- car and its respective parking platform are located in lift-well 20. The lift mechanism is then used to lower that parking platform with its car to ground level. The empty parking platform is, in consequence, rotated into 5 that level so that the net effect is that an occupied parking platform has been replaced with an unoccupied parking platform (though generally in a different location within the parking level).
- 10 If, on the other hand, a car is to be parked at that level, which includes an unoccupied parking platform, the raised parking platform 40 is initially occupied by the car to be parked, so the drive belts - when operated 0 rotate the parked car out of the lift well and continue to 15 rotate until the unoccupied parking platform is located in the lift-well. This unoccupied parking platform can then be lowered by the lifting mechanism to the ground level to await the next car to be parked. Preferably, each level is left in a configuration where any unoccupied parking 20 platforms are adjacent the lift-well so that, in such circumstances, a minimal amount of rotation is required in order to translate an unoccupied parking platform to the lift-well.
- 25 This procedure can be seen more clearly in figure 5, which illustrates a plan view of a full parking level 60 from which a car is to be retrieved. In this figure, inner wall 12 and outer wall 14 have been omitted for the sake of clarity.
- 30 Firstly, an empty parking platform 40 is raised by the lifting mechanism (including inner lift bracket 42 and outer lift bracket 44) to the level of parking level 60. At that point, inner lift bracket 42 and outer lift 35 bracket 44 coincide, respectively, with principal inner bracket 32 and principal outer bracket 36. The drive belts (not shown) then rotate all the parking platforms of

level 60 (including the unoccupied parking platform 40) until the desired car and its respective parking platform are in the lift-well. In this example, the desired car is car B and consequently, as this embodiment is configured 5 so that each level is rotated clockwise when seen from above, level 60 is rotated through almost a complete circuit until car B and its supporting parking platform are aligned with the lift-well. This process is shown nearing completion in figure 6. It will be understood 10 that principal inner bracket 32 and principal outer bracket 36 remain stationary: the parking platforms, driven by the drive belts, rotate within those brackets.

Referring to figure 7, when a car is to be parked at the 15 car park, it enters at the ground level onto a empty parking platform, and is raised by lifting mechanism 62 in which there is at least one vacant parking platform 64. When the lifting mechanism has raised the platform 66 with car 68 to level 62 (as shown in figure 7) the parking 20 platforms of level 62 are rotated until vacant parking platform 64 coincides with the lift-well and loaded parking platform 66 is out of the lift-well. At this point the car 68 can be regarded as having been appropriately parked, and the lifting mechanism can lower 25 vacant parking platform 64 to ground level for receiving another car.

Referring to figure 8A, each of the parking platforms 70, as discussed above, is provided at its inner face 72 and 30 its outer face 74 with teeth that engage the drive belts (the inner of which is shown at 52 in figure 4). Each platform 70 has a size suitable to receive a single (in this embodiment, private) vehicle such that the majority of vehicles can comfortably be accommodated. Referring to 35 figure 8B, in this embodiment the radial length 76 of each platform 70 is approximately 5 m: the outer periphery 74 has a curved length of approximately 3.84 m, and the inner

periphery 72 a length of approximately 2.1 m.

Referring to figures 8C and 8D, the upper surface 82 of each parking platform 70 is provided, at a distance 84 of approximately 1 m from its inner periphery 72, with a stop bump 86 (of height of approximately 0.1 m) to stop a car from driving too far towards inner periphery 72 and thereby colliding with the lifting mechanism, the inner core 12, etc. The upper surface 82 is also patterned to increase traction, at least in those regions 88 where a vehicle's wheels are located when parked on the parking platform 70. This patterning assists a vehicle's ability to brake when entering the parking platform, and to commence exiting the parking platform when desired.

15

The car park is generally controlled centrally, so that a database is maintained of occupied and vacant parking platforms. Consequently, when a new vehicle enters the car park, the operation of the lifting mechanism and the rotation of the correct parking level can proceed essentially automatically. To maximise the speed with which a car is parked, the system will generally raise and rotate a new car to the lowest vacant parking platform. Once a car has been parked, as explained above each parking level is rotated so that any vacant parking platform is adjacent to the lift-well such that rotation of that respective level by one parking platform clockwise will move that vacant parking platform into the lift-well.

30 It may be advantageous to provide more than one exiting point for a car to exit, each situated around the exit level. In one embodiment, the driver re-enters the car (after its retrieval from some other level) and - while the driver preparing for departure - is rotated with the car to one of the plurality of exits.

35 Each of these exits in this embodiment is provided with a

- set of traffic lights, with at least red and green signals. If the driver is ready to exit, he or she can drive out when a green signal is given. If the signal returns to red before the driver is ready (indicating that 5 the car will shortly be rotated further, perhaps owing to the arrival or exiting of another vehicle), the driver need only wait until his or her car has been rotated to the next of the plurality of exits.
- 10 As an alternative to the drive for rotating parking platforms at each level shown in figure 4, in a further embodiment of the invention the platforms at each level are instead driven by a drive platform. This platform is similar to the parking platforms, except that it has an 15 electric motor and - as it is not required to accommodate a vehicle - is narrower than the parking platforms. The parking platforms are pushed or pulled by the drive platform, as is described below.
- 20 Figure 9 is a schematic plan view of an annular parking level 90 according to a second preferred embodiment of the present invention. The parking level 90, along with other like levels, is located (as in previous embodiments) between the inner core 92 and an outer supporting 25 structure 94 of a multilevel car park.

The level 90 comprises a plurality of parking platforms 96 and a drive platform 98. These are all supported on a pair of concentric rails or tracks 100a, 100b laid around 30 the level 90 apart from the gap 102 that, along with comparable gaps at other levels, define the lift shaft. (The first and second rails 100a, 100b are below the platforms 96, 98, but are shown in this figure for explanatory purposes.)

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Figure 10 is a schematic view in cross section of drive platform 98. Drive platform 98 has two pairs of wheels (a

first pair 104 being visible in this figure, joined by axle 106) that, in use, are located in rails 100a, 100b. The drive platform 98 also has an electric motor 108 that obtains power by suitable conventional means. This can be 5 done, for example, by providing a live third rail between the first and second rails 100a, 100b. Drive platform 98 need have only three states of operation: stop, forward and reverse, and these can be effected by controlling the provision of power, or by communicating with a controller 10 (not shown) provided on drive platform 98 by conventional means.

Vehicles are raised and lowered within the lift shaft essentially as described above, but on a parking platform 15 identical to parking platforms 96. However, this platform is raised and lowered on a hoist platform provided with further rail segments that, when aligned with level 90, allow the raised or lowered platform or one of platforms 96 to move from or onto the hoist platform.

20 Thus, in use drive platform is only activated when the hoist platform has been moved to level 90 and thereby completed the ring of platforms at level 90. Drive platform 98 is then activated to drive the complete 25 circuit of platforms in the appropriate direction. This direction is determined according to whether a vehicle is being parked or retrieved. If a vehicle is being parked, the parking platform hoisted to level 90 will be laden and level 90 will already include at least one unladen parking 30 platform 96. The drive platform 98 will rotate the platforms to move the unladen parking platform 96 nearest the lift shaft towards and into the lift shaft (and thereby onto the lift hoist platform). The lift can then lower the hoist platform with empty parking platform for 35 collection of another vehicle.

If a vehicle is being retrieved, the lift raises an empty

parking platform, then the drive platform 98 drives the circuit of platforms until the requested vehicle is in the lift shaft. The lift can then lower the hoist platform with parking platform and vehicle to the exit level.

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It will be understood that the drive platform is only activated when an additional parking platform is located in lift shaft gap 102, so coupling between the platforms is unnecessary. Further, drive platform need not enter 10 the gap 102, as it can be driven in both directions. However, it might be desirable to permit it to cross the gap 102 (while the hoist platform is at level 90) to reduce the time required to effect the required rotation of the platforms.

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This embodiment provides a simpler drive mechanism for rotating the parking platforms, as only the drive platform 98 need be provided with a motor or, indeed, any drive mechanism. The parking platforms 96 are merely shunted 20 into place as required by the drive platform 98.

In a third preferred embodiment of the present invention, a multi-level car park is provided in which a plurality of concentric parking levels, each comparable to - for 25 example - level 60 of figure 5 or level 90 of figure 9. A schematic view of such an arrangement is shown in figure 11, employing the drive mechanism shown in figures 9 and 10. Cars, according to the present invention, are not hoisted within a central core or outside the outer wall of 30 the car park, but rather within a lift shaft defined with each level. Consequently, the addition of one or more further parking platforms arranged around an inner circuit of parking platforms need not impede the parking or retrieval of cars. Thus, referring to figure 11, inner 35 circuit 90 of parking platforms 96 (with drive platform 98) are surrounded by further circuit 90' of parking platforms 96' (with drive platform 98'). Vehicles to be

parked in or retrieved from the inner circuit 90 of parking platforms 96 are raised or lowered in lift shaft 110, while vehicles to be parked in or retrieved from the outer circuit 90' of parking platforms 96' are raised or lowered in lift shaft 110'.

In this embodiment, different entry levels are used for each circuit of parking platforms.

10 In a fourth preferred embodiment of the present invention, the car park performs all necessary tasks to park the car. Figure 12 is a perspective view of this car park 120 in situ in an urban setting. The car park 120 comprises a self-supporting cylindrical steel superstructure 122 that can support cars or other vehicles, each of up to 2500 kg, and up to the 99 percentile vehicle dimension. The superstructure 122 can be built within an existing building, as a stand-alone above ground structure, or underground. In addition, car park 120 comprises a 15 footings (that will be dependent on the soil conditions), steel support columns 124 and steel beams. A balustrade screen 126 at each level can be provided for aesthetic purposes where required, or a full facade screen can be added (not shown).

20

25 A representative level 128 of car park 120 is shown in plan view figures 13A to 13F, together with approach driveway 130 (with ticket booth and book gate 132 and exemplary car 134) and turn-table 136.

30 Level 128 comprises a plurality of parking compartments (in this example sixteen), each in the form of a vehicle parking pallet 138. As in the above embodiments, the vehicle parking pallets 138 fill the entire level 128, 35 with one (pallet 140) located in the lift shaft. This pallet 140 and the other corresponding pallets in the other levels together define a vertical lift, though as

will now be appreciated, the identity of pallets in that lift changes as the car park is used.

The pallets 138 in level 128 (including pallet 140) are  
5 supported on a circular track 142, comprising a pair of concentric rails, for the horizontal transport of vehicles. Pallets 138 are moved around the circular track 142 by a motorised bar unit 144 (comparable to drive platform 98 in the embodiment of figure 9) between a  
10 particular pair of adjacent pallets 138, and impact connections between other pairs of adjacent pallets 138.

Thus, when a vehicle 134 arrive for parking, a swipe card is issued to the driver that identifies that vehicle  
15 throughout the stacking and retrieval process. When the driver returns, the swipe card will activate the system, identify the required vehicle, and return that vehicle to the exit point.

20 The operation of the system is fully automated via a central control computer (not shown) and the aforementioned swipe card system.

25 The vehicle 134 enters the car park driveway 130 and stops at a ticket booth and book gate 132, where a swipe card ticket is issued to the driver. The ticket issued is identified with the vehicle and its awaiting pallet.

Referring to figure 13B, the boom gate opens and the car  
30 134 proceeds to a turn-table 136. The turn-table facilitates access to and egress from the car park 120 for drivers.

A transfer pallet (not shown) has previously been located  
35 on turn-table 136; this transfer pallet is identical in all respects with other pallets 138 being in fact one of those pallets (as will be seen below). It should be noted

that the boom gate will not open until all previous parking operations are complete and the access area is clear of all other vehicles.

5 After parking the vehicle on the transfer pallet on turn-table 136, the driver switches the engine off and all occupants exit the vehicle 134. The driver then proceeds to a ticket recognition booth 148 beside the turn-table 136 and swipes the card to activate the automatic parking system. This provides security against activation whilst the driver remains in the car 134. Following 10 recognition/acceptance of ticket, the turn-table 136 will lock the vehicle 134 in position and rotate to align the car 134 with the lift.

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Referring to figure 13C, once the turn-table 136 with transfer pallet 146 and car 134 are aligned, the pallet 146 and car 134 are mechanically advanced towards the lift on rails 150. Once in position in the lift shaft, pallet 20 transfer 146 is treated as any other pallet 138, and moved automatically onto a lifting mechanism - aligned in anticipation of the arrival of loaded pallet 146 - within the lift shaft.

25 The computer system then determines the optimum stacking location within the car park, and elevates the pallet 146 to the appropriate level (see the partial cross sectional elevation in figure 13D) on lift platform 152.

30 Treating level 128 as the level on which car 134 is to be parked, when the pallet reaches the correct level (see figure 13E), and the pallet wheels are aligned with the circular track 142, the motorised bar unit 144 is activated. The pallets 138 on this level (including 35 loaded pallet 146) are rotated - in this example counterclockwise by one pallet (i.e. 22.5°) - by bar unit 144 to a selected final arrangement (see figure 13F).

Bearing in mind that there is always an empty segment on each full level, this rotation in each case will stop with an empty pallet 154 aligned with the lift shaft (unless it 5 is desired to immediately add or retrieve a vehicle).

That is, when this empty pallet 154 is aligned with the lift platform in the lift shaft, the lift platform can return that pallet to ground level in preparation for a 10 further lift and stack operation. Alternatively, if a vehicle at that level is to be recovered and returned to ground level, that pallet and vehicle will be located on the lift platform for return.

15 For vehicle retrieval, the driver returns and enters the swipe ticket into the booth, selects the retrieve option, and the system automatically retrieves the vehicle from its defined location. Between parking and retrieving any subject vehicle, the system may have performed a number of 20 other stacking operations.

For retrieval of the vehicles, the above-described process is reversed.

25 All storage and retrieval activities are controlled by the central computer, with sensors within the lift system, on the pallets 138 and controlling the motorised bar unit 144. A system of pallet storage and control at ground level minimises wait times for vehicles entering and 30 leaving the car park 120.

In this embodiment, horizontal (i.e. rotational) pallet movement can be effected by other means. Referring to figure 14, pallets 158 in exemplary level 160 can be moved 35 around the circular track 162 by a continuous runner chain 164; the chain has connector links (not shown) to the underside of each pallet 158. The runner chain 164 is

- contained in a guide rail (not shown), with an electric drive motor 166 located in the core 168 of the circular structure (though optionally the drive motor could be located in on the perimeter). The mechanical components 5 of the system in this variation include beams for supporting the rails of the track 162, beams for supporting the runner chain 164, and other equipment supporting. All are supported on secondary steel framing.
- 10 In another variation of this embodiment (shown in figure 15), the pallets 170 are moved around the circular track 172 by powered friction wheels 174. The friction wheels 174 are located approximately 45° apart around the inner perimeter structure 176 and the outer perimeter structure 15 178 of each level 180. Additional friction wheels 182 are located near the lift shaft.

In another embodiment, the arrangements shown in figures 13A to 15 can be employed with a dual ring car park (as 20 described by reference to figure 11). Thus, figures 16A to 16F are comparable to figure 13A to 13F, except that car park 190 of figures 16A to 16F includes two rings 192a, 192b of vehicle pallets 194. Each of these rings 192a, 192b, however, operates in essentially the same way 25 as - for example - the ring comprising pallets 138 in the embodiment of figures 13A to 13F.

Each pallet 194 is supported on a respective track 196a, 196b; each ring 192a, 192b includes a respective 30 motorised drive bar unit 198a, 198b. Each ring 192a, 192b can therefore be rotated independently of the other. For the purposes of loading a car 200, however, only the outer ring 192b of pallets 194 is initially employed. Thus, a car 200 is loaded onto a pallet on turn-table 202 (see 35 figures 16B and 16C) and advanced into the outer ring 192b and described above in the context of figures 13B and 13C. By the approach described above in the context of figures

13A to 13F, it is therefore possible to locate a car 200 in a final pallet 194 in the outer ring 192b. However, referring to figure 16D, if the car is to be located in the inner ring 192a, the car 200 and the pallet 204 on which it is being carried are firstly raised to the final level 206 at which the car 200 is to be parked. The inner ring of this level (see figure 16E) will have previously been rotated so that an empty pallet 208 is aligned with the lift shaft in the outer ring. Once raised to the correct level 206, the car is drawn mechanically from pallet 204 in the outer ring onto pallet 208 in the inner ring. The inner ring is rotated (see figure 16F) so that an empty pallet 210 is again located adjacent to the lift shaft 212 of the outer ring, and to carry the car 200 to its final location 214.

Figures 17 and 18 are double ring versions of the variations of the previous embodiment shown in figures 14 and 15. In figure 17, each of inner ring 216a and outer ring 216b is provided with its own respective continuous runner chain 218a, 218b and respective electric drive motor 220a, 220b. With separate drive motors 220a, 220b, inner and outer rings 216a, 216b can be rotated independently.

In figure 18, each of inner ring 222a and outer ring 222b is provided with its own respective set of powered friction wheels 224a, 224b. Again, this means that inner and outer rings 222a, 222b can be rotated independently.

Thus, the embodiments of figures 12 to 18 provide car park systems than can be built above or below ground, eliminate vehicle exhaust emissions during car park access and the parking process, and minimises land area required. The steel-framed structure allows off-site fabrication, rapid on-site installation, and hence minimal on-site labour. These systems are relatively quiet, and provides a high degree of security for parked vehicles.

Modifications within the scope of the invention may be readily effected by those skilled in the art. It is to be understood, therefore, that this invention is not limited  
5 to the particular embodiments described by way of example hereinabove.

It should be understood that references herein to prior art are not intended to suggest that any such prior art is  
10 common general knowledge.